Intergovernmental Oceanographic Commission
Reports of Meetings of Experts and Equivalent Bodies

Working group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG)

Inter-ICG Task Team 3 on Tsunami Watch Operations

First Meeting
Seattle, USA
29 November–1 December 2010

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IOC/TOWS-WG/TT3-I/3*
Paris, France
June 2011
English only

For more information see also the summary report of IOC/TOWS-WG-IV/3

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1. INTRODUCTION

The IOC Tsunami Programme, through the coordination of regional meetings, capacity-building activities and the support of national and regional projects is a key stakeholder for tsunami risk reduction at global level. Four Intergovernmental Coordination Groups (ICGs) corresponding to the regions Pacific, Caribbean, Indian Ocean and Mediterranean have been established to address particular regional needs.

1.1 WORKING GROUP ON TSUNAMI AND OTHER HAZARDS RELATED TO SEA LEVEL WARNING AND MITIGATION SYSTEMS (TOWS-WG)

IOC Resolution XXIV-14, based on findings of the ad hoc Working Group, approved a proposal for the establishment of a permanent global Working Group on Tsunami and Other Hazards related to Sea-level Warning and Mitigation Systems (TOWS-WG). It comprises representatives of all relevant IOC subsidiary bodies and those from UN sister agencies, like ISDR and WMO, as well as representatives of relevant stakeholders.

IOC charged its Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG) to review the governance and organization of the ICG's of all Tsunami Warning Systems to ensure common operation explore synergy effects and mainstream in particular the upstream activities, i.e. detection and verification, into existing ocean observing systems.

The IOC Assembly at its 25th session adopted Resolution XXV-13 in 2009, which decided to establish the following task teams:

- Inter-ICG Task Teams on Sea Level for Tsunami Purposes.
- Inter-ICG Task Team on Disaster Management and Preparedness.
- Inter-ICG Task Team on Tsunami Watch Operations.

The establishment of these task teams was to meet the need for and the benefit from enhanced coordination, common requirements, and exchange knowledge and information among the ICGs.

1.2 INTER-ICG TASK TEAM ON TSUNAMI WATCH OPERATIONS

The current Task Team on Tsunami Watch Operations is working towards harmonization of methods and standards issuance of tsunami advisories, advising on modalities of operation and developing guidelines for the requirements of Regional Warning Systems. The detailed Terms of Reference of this Task Team include:

- Provide a mechanism to the ICGs for coordination of tsunami watch operations among the Tsunami Warning Systems;
- Document current and proposed products and their dissemination methods, working through existing ICG working groups or their equivalents;
- Review terminology and recommend harmonized terminology;
- Document areas of responsibilities, geographical coverage, system architectures, and other relevant characteristics;

- Develop consensus on uniform standards, procedures and guidelines for tsunami watch operations, including a process for verifying the operational status of Regional Tsunami Watch Providers;
- Develop guidelines for the review of tsunami watch operations.

1.3 MEMBERS OF THE TASK TEAM:

Sl No.	TWS	Member
1.	IOTWS	Srinivasa Kumar, Chair
2.	IOTWS	Charles Ngunjiri
3.	PTWS	Chip McCreery
4.	PTWS	Takeshi Koizumi
5.	CARIBE-EWS	Christa von Hillebrandt
6.	CARIBE-EWS	Emilio Talavera
7.	NEAMTWS	Luis Matias
8.	NEAMTWS	Gerassimos Papadopoulos
9.	Secretarial Support	Tony Elliott

The Task Team conducted its work through email and during the Inter-ICG Task Team meeting held at Seattle from 29 November to 1st December 2010. The Task Team also benefitted from the numerous documents and publications brought out by different ICGs and other international organizations. Important reference documents are listed as Annex IV.

2. REVIEW OF CURRENT OPERATIONAL SYSTEM

2.1 THE INDIAN OCEAN TSUNAMI WARNING MITIGATION SYSTEM (IOTWS):

The Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS) was formed in response to the tragic tsunami on 26 December 2004, in which over 250,000 lives were lost around the Indian Ocean region. The IOC Assembly, during its 23rd Session (21–30 June 2005), formally established the ICG/IOTWS through Resolution XXIII-12. The main objective of the IOTWS is to identify and mitigate the hazards posed by local and distant tsunamis. The goal is to create a fully integrated end-to-end warning system comprising three key components: hazard detection and forecasting; threat evaluation and alert dissemination; and community preparedness and response. The work of the IOTWS is conducted by three working groups and a Task Team whose members are experts in their fields, responsible for establishing standards and for developing work plans. They report their recommendations to the ICG for endorsement and implementation.

- Working Group 1 – Tsunami Risk Assessment and Reduction
- Working Group 2 – Tsunami Detection, Warning and Dissemination
- Working Group 3 – Tsunami Awareness and Response
- Task Team on Regional Tsunami Watch Providers

2.1.1 Operational Centres, System Architecture and Area of Responsibility

PTWC and JMA as Interim Advisory Service Providers: An interim IOTWS was declared operational in July 2006, the backbone of which at the regional level is the Interim Advisory Service (IAS), which provides tsunami advisory and watch information directly to the 24/7 National Tsunami Warning Centres (NTWC) of the IOTWS Member States (MS). The PTWC and JMA are providing such Interim Advisory Services (IAS) to Indian Ocean region. While PTWC & JMA have no authority or responsibility to issue tsunami warnings outside their regions of responsibility, they have been acting as a backbone and providing tsunami-relevant information to Indian Ocean nations on an interim basis.

RTSPs (by mid–2011): By the target date of mid–2011, the responsibility of providing tsunami advisories to the IOTWS Member States will be taken over by a number of Regional Tsunami Advisory Service Providers (RTSP) located in the Indian Ocean region. Tsunami advisories will be disseminated from each IOTWS RTSP to the TWFPs & other RTSPs as an interoperable system of systems, with the IAS centres acting as a backup. Several countries in the IOTWS region such as Australia, India, Indonesia and others have established RTSP capabilities.

Geographical coverage of IOTWS includes the Indian Ocean Region as depicted in Figure 1

Figure 1. Indian Ocean Geographical Coverage Area

2.1.2 Operational Procedure

Interim Service provided by JMA and PTWC for the IOTWS are based on earthquake source information to determine potential tsunami threat and travel times. The criteria used by PTWC & JMA for generation of tsunami advisories are tabulated below:

Sl No	Criteria	Product
1.	Mw: 6.5 – 7.0	Tsunami Information Bulletin with Potential destructive tsunami threat very small or none.
2.	Mw: 7.1 – 7.5	Local Tsunami Watch with Potential or confirmed destructive tsunami threat to coasts within about 200 km of the earthquake epicenter.

Sl No	Criteria	Product
3.	Mw: 7.6 – 7.8	Regional Tsunami Watch with Potential or confirmed destructive tsunami threat to coasts within about 1000 km of the earthquake epicenter.
4.	Mw: 7.9 – 9.9	Indian Ocean wide Tsunami Watch with Potential or confirmed destructive tsunami threat to all coasts bordering the Indian Ocean.

2.1.3 Current Products

Interim Advisory Service: PTWC

- Tsunami Information Bulletins
- Local, Regional or Indian Ocean-Wide Tsunami Watch Bulletins

Interim Advisory Service: JMA

- Local, Regional or Indian Ocean-Wide Tsunami Watch Information

2.1.4 Dissemination Methods

The tsunami advisory bulletins are disseminated to TWFPs of the IOTWS Member States by FAX, Email, Web and GTS.

2.1.5 Proposed Products

RTSPs will provide services in two forms: PUBLIC Services and ADVISORY (Exchange) Services. RTSPs will issue more specific tsunami information for NTWCs such as Estimated Wave Amplitude (EWA), Estimate Time of Arrival (ETA), Potential threat zones, etc. generated from forecast models. The proposed products will be categorized as Bulletin-1, Bulletin-2, Bulletin-3, Bulletin-... and Final Bulletin.

2.2 PACIFIC TSUNAMI WARNING SYSTEM (PTWS)

The Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System (ICG/PTWS) first convened in 1968. The system, initially designed as a central system for far-field tsunamis is addressing the requirements for near-field sources and regional sub-systems. The work of the PTWS is conducted by three sessional working groups, four regional working groups and two task teams

- Working Group 1 – Tsunami Risk Assessment and Reduction.
- Working Group 2 – Detection, Warning and Dissemination.
- Working Group 3 – Awareness and Response.
- Regional Working Group on the South China Sea.
- Working Group for the South West Pacific.
- Working Group for the South East Pacific.
- Working Group for Central America.

- Task Team on Pacific Wave Exercise.
- Task Team on Pacific Emergency Communications.

2.2.1 Operational Centres, System Architecture and Area of Responsibility

Tsunami information and warning products are disseminated from PTWC, WCATWC, and NWPTAC to TWFPs of their respective areas of responsibility within the Pacific region. The AORs of individual centres for the PTWS are described below:

- PTWC – PTWC's area-of-responsibility (AOR) for issuing PTWS warnings and other messages includes all coasts in the Pacific Ocean except those covered by WC/ATWC (Alaska, British Columbia, Washington, Oregon, and California) as illustrated on Figure 2.
- WC/ATWC – WC/ATWC's area-of-responsibility (AOR) within the PTWS is the Pacific coasts of the U.S. States of Alaska, Washington, Oregon, and California as part of the US National Tsunami Warning System, as well as the Pacific coast of Canada through a bilateral agreement. WC/ATWC collaborates with the Pacific Tsunami Warning Center PTWC to provide tsunami warning services, and mutual backup, to tsunami threatened areas throughout the United States and the PTWS. See Figure 2.
- NWPTAC (JMA) – The Northwest Pacific Tsunami Advisory Centre's area-of-responsibility includes the northwestern and a portion of the southwestern Pacific and, on interim basis, the South China Sea regions as represented on Figure 3.

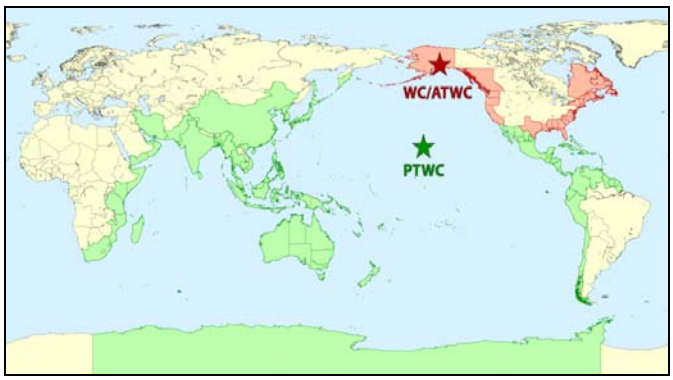

Figure 2. PTWC & WC/ATWC Geographical Coverage Area

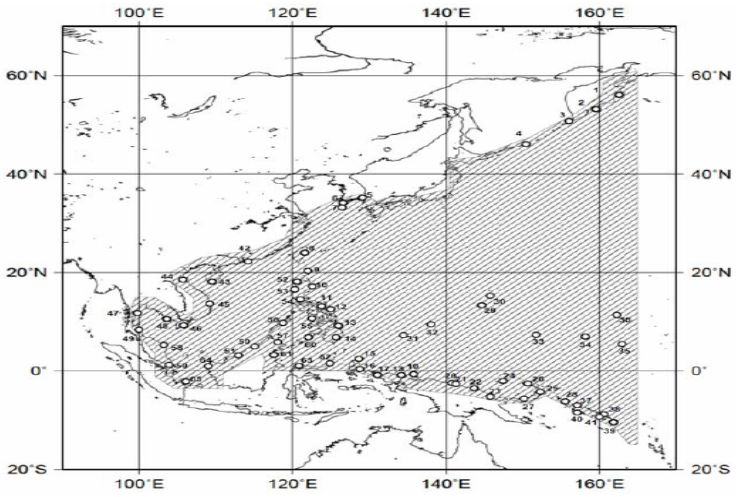

Figure 3. NWPTAC (JMA) Geographical Coverage Area

2.2.2 Operational Procedure

Earthquake source information is used to determine potential tsunami threat and travel times. The criteria used by PTWC, WC/ATWC & NWPTAC for generation of tsunami advisories for the PTWS are tabulated below:

PTWC

Sl No	Criteria	Product
1.	Mw: 6.5 – 7.5	Tsunami Information Bulletin with evaluation that a widespread destructive tsunami was not generated.
2.	Mw: 7.6 – 7.8	Regional fixed Tsunami Warning Bulleting for coastal areas within 1000km of the epicentre.
3.	Mw > 7.8	Regional Expanding Tsunami Warning & Watch Bulletin putting areas within 3 hours tsunami estimated time of arrival (ETA) into a Warning and area within 3-6 hours tsunami ETA into Watch.
4.	Confirmed Tsunami with destructive potential far from the source	Pacific wide Tsunami Warning Bulleting putting all coastal areas in a Warning.

WC/ATWC

Sl No	Criteria	Product
1.	Ms < 6.5	Alaska, British Columbia, West Coast Of U.S. Issue information message if appropriate
2.	Ms = 6.5 and less than warning Thresholds	Alaska, British Columbia, West Coast Of U.S. Issue Tsunami Information Bulletin
3.	Ms = 6.5 & ≤ 7.5	Pacific Basin Outside Of Alaska And Canada/U.S. West Coast Issue Tsunami Information Bulletin
4.	Ms > 7.0	Alaska West Of Unimak Pass (165w) 1. Issue a warning to area within 3 hours travel time of the expected bulletin issuance. 2. Issue a watch to the area within 3 and 6 hour travel time. 3. Monitor tide gages.

Sl No	Criteria	Product
5.	Ms > 7.0	Alaska Bering Sea Only 1. issue a warning to alaska's pribilof island and aleutian islands from attu to false pass only. 2. there is no watch area. 3. monitor tide gages.
6.	Ms > 7.0 & ≤ 7.5	Alaska East Of Unimak Pass, U.S./Canada West Coast 1. Issue a warning to area within two hours travel time of the expected bulletin issuance. 2. Issue a watch to the area within 2 and 3 hour travel time. 3. Monitor tide gages.
7.	Ms > 7.5	Alaska East Of Unimak Pass, U.S./Canada West Coast 1. Issue Tsunami warning to area within 3 hours travel time of the expected bulletin issuance. 2. Issue a watch to the area within 3 and 6 hour travel time. 3. Monitor tide gages.
8.	Ms > 7.5	Pacific Basin Outside Of Alaska And Canada/U.S. West Coast 1. If the epicentre is within 6 hours tsunamis travel time of any part of the WC/ATWC area of responsibility: a. Issue a warning to the area within 3 hours travel time of expected bulletin issuance. b. Issue a watch to the area within 3 and 6 hours travel time. c. Monitor tide gauge data. 2. If the epicentre is more than six hours travel time from any part of the WC/ATWC area of responsibility, issue a Tsunami 3. Advisory Bulletin.

WCATWC also issues products for Puerto Rico, US and British Virgin Islands

NWPTAC

Sl No	Criteria	Product
1.	6.5<M*<7.0	NWPTA** with evaluation that very small possibility of a destructive local tsunami.
2.	7.0<M*<7.5	NWPTA** with evaluation that possibility of a destructive local tsunami within 100 km of the epicentre.
3.	7.5<M*<7.8	NWPTA** with evaluation that possibility of a destructive regional tsunami within 1,000 km of the epicentre.
4.	M*>7.8	NWPTA** with evaluation that possibility of a destructive ocean-wide tsunami.

M*: Mw or Mjma
NWPTA**: North West Pacific Tsunami Advisory

2.2.3 Current Products

PTWC

- Tsunami Information Bulletin
- Regional Fixed Tsunami Warning Bulletin
- Regional Expanding Tsunami Warning and Watch Bulletin
- Pacific-Wide Tsunami Warning Bulletin

Northwest Pacific Tsunami Advisory Center – NWPTAC

- Local, Regional, northwest and portion of southwest Pacific Tsunami Advisories

West Coast/Alaska Tsunami Warning Center (WC/ATWC)/PTWC Domestic Products

- Information Statement
- Tsunami Warning Message
- Tsunami Advisory Message
- Tsunami Watch Message

2.2.4 Dissemination Methods

GTS; AFTN; EMWIN; Fax; Email; Web; AWIPS; NWW; NAWAS; HAWAS; IDN.

2.3 TSUNAMI AND OTHER COASTAL HAZARDS WARNING SYSTEM FOR THE CARIBBEAN SEA AND ADJACENT REGIONS (CARIBE-EWS):

The Intergovernmental Coordination Group for the Tsunami and other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (ICG/CARIBE EWS) was

established in 2005 as a subsidiary body of the IOC/UNESCO with the purpose of providing efficient assistance on tsunami risk reduction to Member States in the Caribbean region. The work of the CARIBE-EWS is conducted by four working groups.

- Working Group 1 – Monitoring and Detection Systems, Warning Guidance
- Working Group 2 – Hazard Assessment
- Working Group 3 – Warning Dissemination and Communication
- Working Group 4 – Preparedness, Readiness and Resilience

2.3.1 Operational Centres, System Architecture and Area of Responsibility

Currently, tsunami information and watch products are disseminated from PTWC to the TWFPs of all countries of the Caribbean and adjacent regions, except Puerto Rico, US and British Virgin Islands which are currently covered by WCATWC. Future plans are for these tsunami products to be disseminated from a Caribbean Tsunami Warning Centre. This system will be interoperable within the Caribbean basin and as well as with other regional and global TWC's and RTWP.

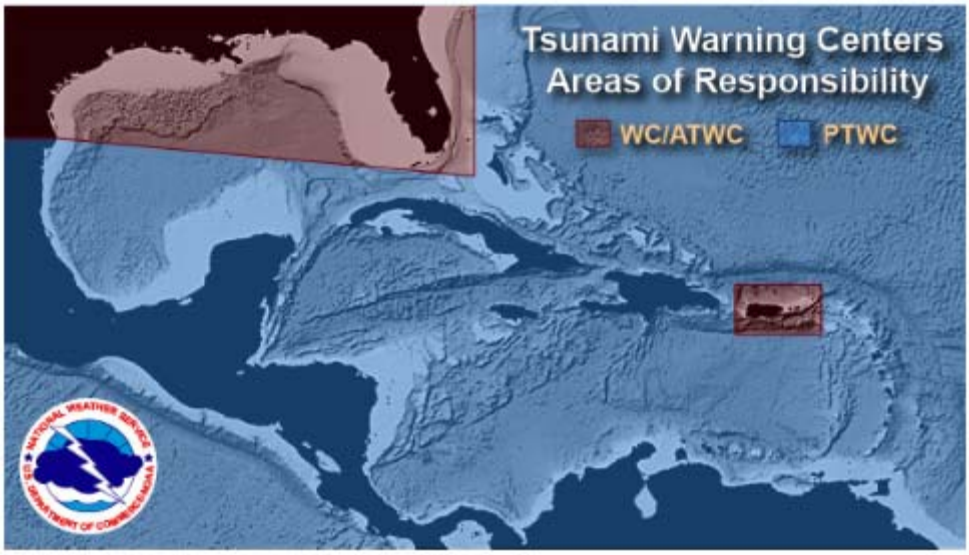

Figure 4. CARIBE-EWS Current Geographical Coverage Area and distribution of Areas of Responsibility for issuing tsunami products

2.3.2 Operational Procedure

Earthquake source information is used to determine potential tsunami threat and travel times. The criteria used by PTWC & WC/ATWC for generation of tsunami advisories for the CARIBE-EWS are tabulated below.

Sl No	Criteria	Product
1.	Mw: 6.5 – 7.0 (Caribbean)	Tsunami Information Statement with evaluation that a very small possibility of a destructive local tsunami.
2.	Mw: 6.5 – 7.8 (Atlantic)	Tsunami Information Statement with evaluation that a very small possibility of a destructive ocean-wide tsunami.

Sl No	Criteria	Product
3.	Mw: 7.1 to 7.5 (Caribbean)	Local Tsunami Watch with evaluation that Potential for destructive local tsunami.
4.	Mw: 7.6 – 7.8 (Caribbean)	Regional Tsunami Watch Bulletin with evaluation that Potential for a destructive regional tsunami.
5.	Mw > 7.9 (Caribbean & Atlantic)	Ocean-wide Tsunami Watch with evaluation that Potential for a destructive ocean-wide tsunami.

2.3.3 Current Products

Interim Advisory Service: PTWC

- Tsunami Information Statement.
- Local, Regional and Caribbean-wide Tsunami Watch.

West Coast/Alaska Tsunami Warning Center (WC/ATWC)

- Information Statement.
- Tsunami Warning Message.
- Tsunami Advisory Message.
- Tsunami Watch Message.

2.3.4 Dissemination Methods

Fax; NWW; Email; SMS; AWIPS; Web; RSS feed; EMWIN.

2.3.5 Proposed Products

- Tsunami Information Statement
- Tsunami Warning Message
- Tsunami Advisory Message
- Tsunami Watch Message

2.4 THE TSUNAMI EARLY WARNING AND MITIGATION SYSTEM IN THE NORTH EASTERN ATLANTIC, THE MEDITERRANEAN AND CONNECTED SEAS (NEAMTWS)

The Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North-Eastern Atlantic, the Mediterranean and connected seas (ICG/NEAMTWS) was formed in response to the tragic tsunami on 26 December 2004. The IOC Assembly, during its twenty-third Session (21 – 30 June 2005), formally established the ICG/NEAMTWS through Resolution IOC–XXIII–14. The work of the NEAMTWS is conducted by four working groups and three task teams.

- Working Group 1 – Hazard Assessment and Modelling
- Working Group 2 – Seismic and Geophysical Measurements

- Working Group 3 – Sea Level Data Collection and Exchange, Including Offshore Tsunami Detection and Instruments
- Working Group 4 – Public Awareness, Preparedness and Mitigation
- Task Team on the Regional Tsunami Warning System Architecture
- Task Team on Communication Test and Tsunami Exercises
- Task Team on the Multi-hazard Approach to Coastal Inundation

2.4.1 Operational Centres, System Architecture and Area of Responsibility

NEAMTWS area includes North-Eastern Atlantic, The Mediterranean and connected seas (Marmara Sea and Black Sea) as depicted in Figure 5. There is currently no tsunami warning centre providing services to this region. The system is in the building-up stage with the improvement of instrumental and telecommunication infrastructure, while test communications for message exchanges were successfully performed by national centres during 2010 and scheduled to repeat within 2011. Currently the architecture of the system is under design.

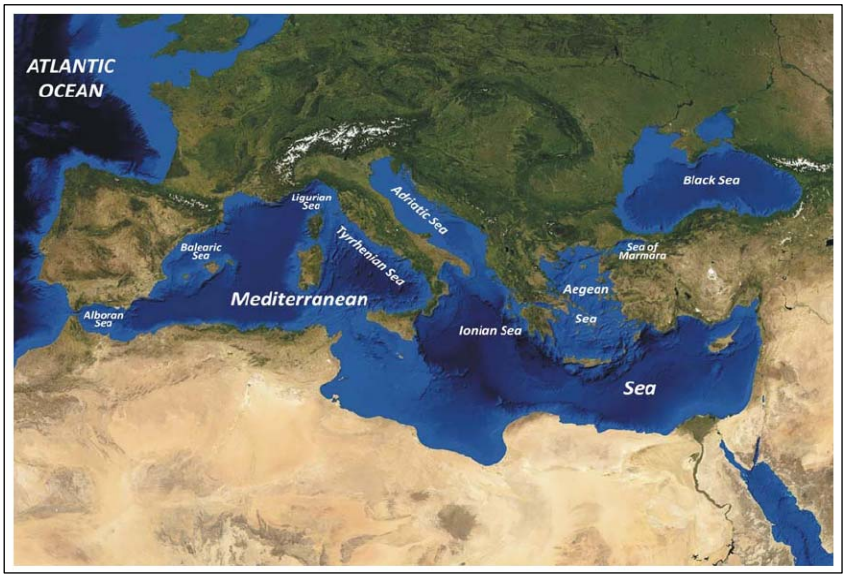

Figure 5. NEAMTWS Geographical Coverage Area

2.4.2 Proposed Products

- Tsunami Watch Message.
- Tsunami Advisory Message.
- Tsunami Information Message.

3. RECOMMENDATIONS FOR GLOBAL HARMONIZATION

Considering the heterogeneous ways of data management, communication, warning and mitigation practices in tsunami and other ocean hazard warning systems, it is recommended to work towards developing and exploiting synergies amongst all regional warning systems. In order to identify the potential gaps in the present systems, particularly where no system exists, providing an outline for the development of a strategy for tsunami is very important.

All four systems are now focusing on optimizing and improving their performance. They also improve the levels of consistency between participating members and among them, particularly in the detection and verification parts. For the production, formulation and dissemination of advisories, alerts, alarms and nationally mandated warnings, common procedures are to be developed, and performance measures introduced. The development and implementation of interoperable systems for tsunamis can only be achieved through close consultation, coordination and cooperation among all stakeholders.

Standardization and harmonization of tsunami operations across the Regional Centres and across the ICGs is highly desirable. At the same time, the system should be flexible enough to include local and regional considerations, both scientific and logistical.

The recommendations of this Task Team are expected to be a starting point towards bringing in the much needed harmonization and synergy between different regional systems and result in a global “System-of-systems” for delivery of tsunami advisories for all the global coastlines threatened by tsunami.

3.1 AOR AND SYSTEM ARCHITECTURE

Regional Tsunami Warning Systems operating in each ICG (viz. IOTWS, PTWS, NEAMTWS, CARIBE EWS) are the building blocks of a global TWS. Global coverage of the four ICGs is shown in Figure 6. It may be noted that there are some coasts that are not covered by any Regional TWS but are covered by a National TWC that is in turn part of one or more Regional TWS.

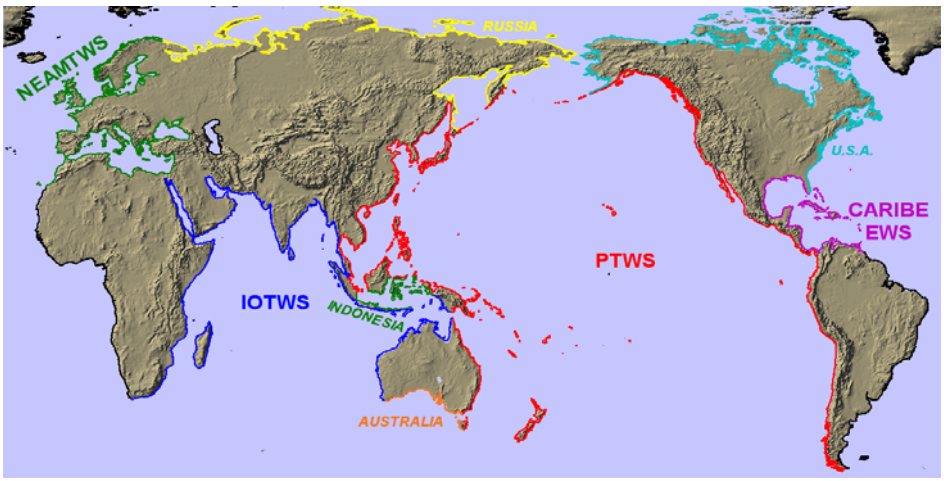

Figure 6. Global coverage of the four TWSs is shown in this picture. Some coasts are not covered by a TWS but are covered by a national TWC that is part of one or more TWSs

It is proposed that the coverage of each regional tsunami warning system and the Area of Responsibility (AOR) of RTSPs operating within a regional tsunami warning system should be decided by the respective ICGs. While addressing the above aspects, it is to be ensured that these systems should offer coverage to the coastal regions of all IOC as well as non IOC Member States that are vulnerable to a tsunami.

Each Regional Tsunami Warning System will ideally comprise of National Tsunami Warning Centres (NTWC)/National Tsunami Warning Focal Points (NTFPs) in each country receiving tsunami advisories from one/more Regional Tsunami Advisory Service Providers (RTSP).

The RTSPs will distribute the products to NTWCs/NTFPs and to other RTSPs operating within the ocean basin. Ultimately it is the NTWCs/NTFPs, operating within the

legal framework of the sovereign nation in which they reside and serve, that provide warnings, watches, and advisories to their citizens, public and private agencies. These warnings are based either on the NTWC's own analysis of the situation, on the advisory messages received from RTSPs, or on a combination of both.

As a backup to service for each region, there should be more than one RTSP operational and share information with each other and NTWCs via, for example, GTS, web sites, RSS feeds, fax, emails, etc., in standard formats. Not only with the RTSPs of same ocean basin, they should be interoperable with other ocean basin RTSPs, i.e. use common and agreed formats for information exchange, address service requirements, follow agreed, high-level operating Standard Operating Procedures (SOPs), share information on procedures and processes. The global TWS therefore operates as a "System-of-systems".

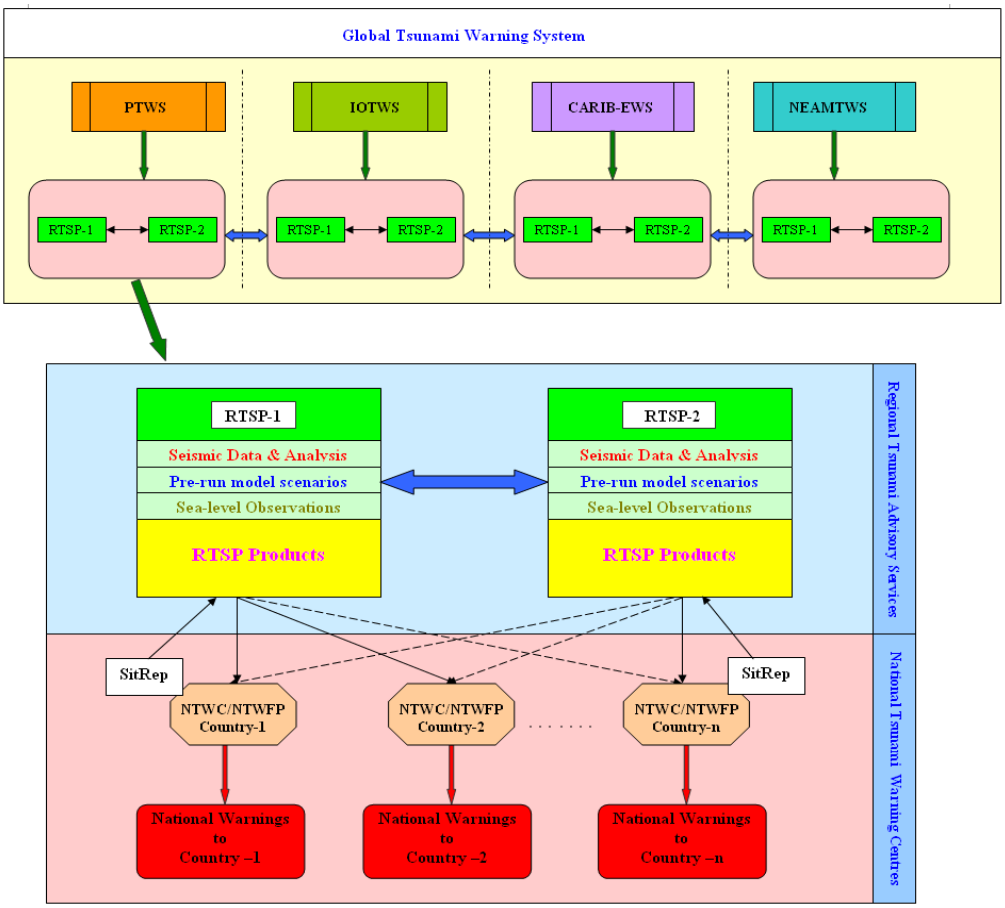

Figure 7. Proposed System Architecture

3.2 OPERATIONAL ELEMENTS OF A REGIONAL TWS

At the heart of a regional tsunami warning system are the NTWCs & RTSPs operating 24 hours per day, 7 days per week. An RTSP should do two things as fast as possible: locate any moderate or larger sized earthquake, and assess its magnitude. Once that is accomplished, they can begin to assess any potential tsunami threat to the regions in its area-of-responsibility (AOR). The first tsunami bulletin issued by a RTSP is usually based on seismic information. Later bulletins follow-up model based forecasts and/or with sea-level observations. The real-time sea-level observations are a key element as they are used to help confirm the existence of a tsunami or cancel a tsunami warning. However, for the areas which are very close to the source, the time for confirmation may not exist. In such cases, the use of numerical modelling to determine the potential run-ups and inundation from a

local or distant Tsunami is recognized as useful and important tool. Models can be initialized with potential worst case scenarios for the Tsunami sources or for the waves just offshore to determine corresponding impact on nearby coast. This information then forms the basis for creating tsunami inundation & evacuation maps and procedures. Hence the operational elements of an RTSP include seismic data analysis, sea-level data analysis, tsunami modelling and forecasting, tsunami advisory preparation as well as dissemination.

3.2.1 Regional Tsunami Advisory Service Provider (RTSP)

A Regional Tsunami Advisory Service Provider will provide tsunami forecasts and other information to the NTWCs of another or several other countries in a particular region or oceanic basin. An RTSP may also serve a dual role as the NTWC for the country in which it resides. Roles and Responsibilities of a RTSP are described below:

- Determine and provide timely initial earthquake information;
- Determine more specific threat information using output from scenario databases produced by tsunami models, using earthquake source information and verified by sea level information;
- Provide timely tsunami advisories for use in preparation and issuing of national tsunami warnings by NTWCs;
- Monitor tsunami propagation and provide updated information (observed tsunami amplitude measurements) in priority;
- Provide timely standardized Situation Reports (SitReps) for use by other RTSPs and NTWCs;
- Serve as a backup centre to other RTSPs;
- Serve as an NTWC for the country in which it resides.

3.2.2 National Tsunami Warning Centre (NTWC)

A National Tsunami Warning Centre (NTWC) operates within the legal framework of the sovereign nation in which it resides and serves. It provides warnings, watches, and advisories to its citizens and public and private agencies according to its national mandate. Recommended roles and responsibilities of a NTWC are described below:

- Responsible for making decisions, using RTSP advice of their choice, and issuing tsunami warnings to its communities.
- Provide timely standardized Situation Reports (SitReps) for use by other NTWCs and RTSPs, including the status of their warnings.
- Consult with and provide information to RTSPs on forecast point locations.
- Work out arrangements with RTSPs for advice on how to utilize RTSP products to determine local impacts/threats.
- Establish threat levels and develop SOPs for the corresponding jurisdictions. Utilize RTSP products for initializing inundation model output/selecting inundation scenarios.
- Conduct hazard mapping and risk assessments using source hazard information (e.g. historic/potential earthquakes, volcanoes) inundation models/maps and vulnerability assessment.
- Provide information/warnings and work with emergency management authorities on how to determine threat zones and develop/select appropriate evacuation maps.

3.3 STANDARD OPERATING PROCEDURES

To be interoperable, the RTSPs need to have a common high-level SOP. However, each individual RTSP needs to create more detailed SOPs to reflect their site specific operating environment. Figure 8 shows the three stages of tsunami advisory activities, including the roles and interactions, typical input and output information between RTSPs and NTWCs. The three stages are:

- Stage 1: Identify Threat.
- Stage 2: Threat Information Exchange and Dissemination.
- Stage 3: Update Advice.

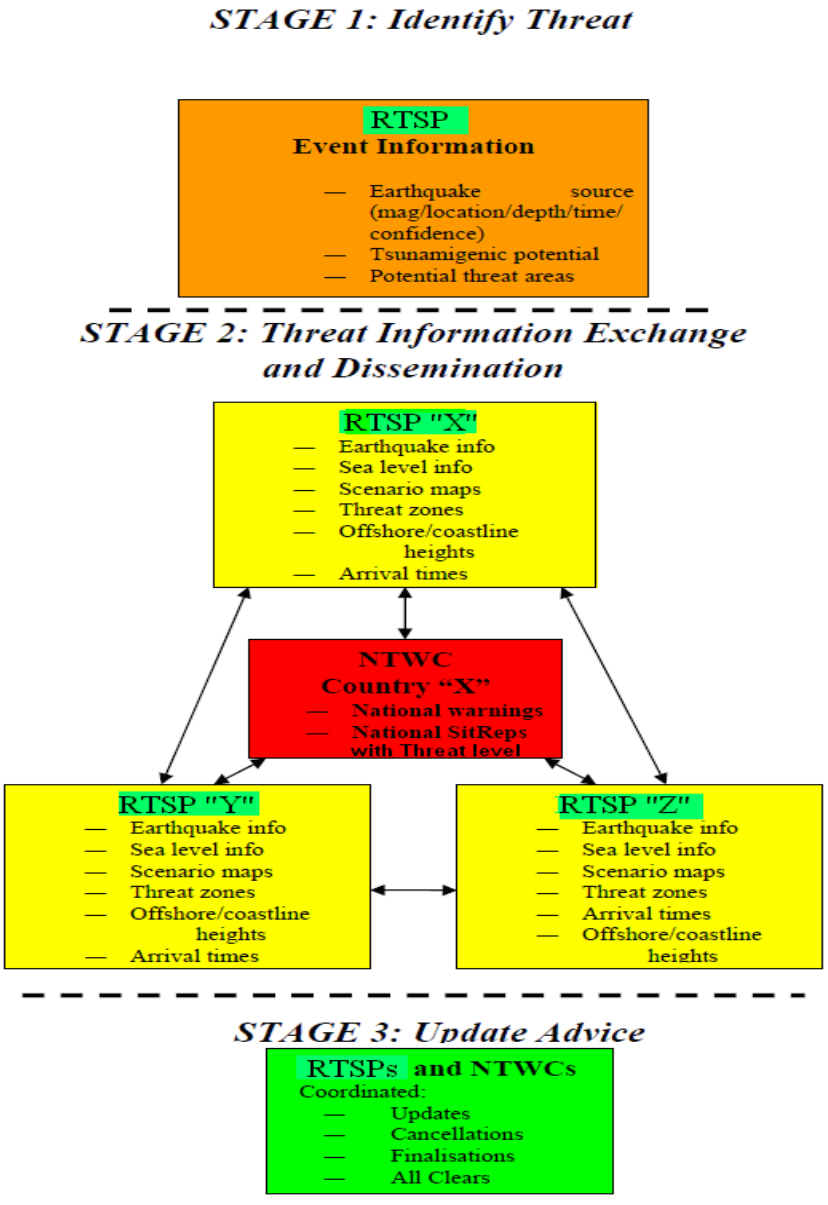

Figure 8. RTSP's SOP

3.4 HARMONIZED PRODUCTS AND TERMINOLOGIES

NTWCs and RTWPs should strive to adhere to internationally agreed-upon products in interoperable formats. If these products are similar in name and content from one centre to the next, confusion among users will be minimized.

Harmonized products for the regional tsunami watch providers are proposed for the UNESCO/IOC Tsunami Warning Systems. The proposal is summarized in Table 1. The scheme is based on the different response actions that would be recommended by the National Authorities. The scheme also recognizes that it is the responsibility of the National stakeholders to issue tsunami warning products, while the regional centres provide the information necessary to facilitate the decision-making process. Unlike for most other disasters, tsunamis have a very rapid onset and therefore leave little time for coordination between the stakeholders.

The main stakeholders in the tsunami notification scheme are:

- Civilians/Public;
- National authorities responsible for public safety;
- National Tsunami Warning Centres or National Tsunami Warning Focal Points which will establish the threat level for the corresponding jurisdictions;
- Regional Tsunami Advisory Service Providers that will provide guidance to the National Tsunami Warning Centres and Focal Points;

Four different level of emergency response were identified:

- Evacuation of areas of potential tsunami inundation;
- Clearance of beaches, marine infrastructure and coastal waters due to expected strong currents and oscillations in sea level;
- On alert in the event that there exists the potential of a tsunami, but given the travel time of the waves, no immediate action is required until more information is available;
- No action necessary, this is in the case of a distant tsunami or a tsunami in another basin which will have no impact on the local area.

Four different levels of threat will represent the potential impact of the tsunami on the jurisdictions. The decision on the level of threat will be determined by the National Tsunami Warning Centres or Focal Points, who in turn will report these back to the Regional Tsunami Advisory Service Providers.

Threat Level	Potential Impact
0	No impact expected, no flooding, no currents.
1	There is a potential for tsunami impact, but given the travel time, no response of the public is necessary at the moment.
2	Threat to coastal marine areas due to strong currents and oscillations in sea level.
3	Threat of tsunami inundation.

The Regional Tsunami Advisory Service Providers will generate two types of bulletins: Public Tsunami Bulletins and Tsunami Exchange Bulletins.

(i) **Tsunami Public Bulletins**: These bulletins will be widely distributed in various formats and through public and private communication systems (GTS, Email, Fax, Web, SMS, etc.) necessary to facilitate a broad reception, including the global media. There will be the first bulletin, and in the case of a potential threat, updates will be issued.

(a) Bulletin 1: Will include earthquake parameters (latitude, longitude, depth, magnitude) and indicate if there is the potential for a destructive tsunami for a certain area. The potential for a destructive tsunami will be defined as potential, undetermined potential (for situations where the travel time is greater than 2 or 3 hours) or no potential. These bulletins will be issued within minutes of the earthquake.

(b) Bulletin 2, 3, 4…: These bulletins will provide an update on the earthquake parameters (latitude, longitude, depth, magnitude, and origin time), the threat level as reported by the National authorities to the Regional Tsunami Watch Providers.

(ii) **Tsunami Exchange Bulletins:** These bulletins will be issued by the RTSP to the NTWC/NTWFP. The distribution of the bulletins will be private and websites with the products will be password protected. There will be the first bulletin, and in the case of a potential threat, updates will be issued.

(a) Bulletin 1: Will include earthquake parameters (latitude, longitude, depth, magnitude), level of tsunami threat, estimated times of arrival and estimated wave amplitude/inundation information. These bulletins will be issued within minutes of the earthquake.

(b) Bulletin 2, 3, 4…: These bulletins will provide an update on the earthquake parameters (latitude, longitude, depth, magnitude), the recorded/reported wave amplitudes, estimated and observed wave arrival times, run-up, maximum positive wave amplitude at shoreline (inundation).

(c) Final Bulletin: This will be the last bulletin issued by the RTSP for an event, indicating that the threat has passed, based on pre-defined criteria. This will form the basis for issue of Threat Cancellation or All Clear by the concerned authorities.

Products should be made available as both text and graphics in all possible formats, as required by the NTWCs.

Table 1: Harmonization of Products to be Issued by Regional Tsunami Advisory Service Providers (RTSPs) for the UNESCO IOC TWS

RTSP Service	**RTSP to Public (Tsunami Public Bulletins)**			**RTSP to NTWC (Tsunami Exchange Bulletins)**			**NTWC to Public/National/Local Authorities/RTSPs (Threat Categorization)**			**NTWC Service**
Bulletin Types	**Bulletin 1**	**Bulletin 2, 3, 4…**	**Final Bulletin**	**Bulletin 1**	**Bulletins 2, 3, 4….**	**Final Bulletin**	**Threat level**	**Potential Impact**	**Public Response**	
Contents of the Bulletins	EQ Parameters, **Potential for Destructive Tsunami** (within certain distance from epicenter)	EQ Parameters, **Potential for Destructive Tsunami**, Threat Level as reported by NTWC, Tsunami Observations	--	EQ Parameters, **Tsunami Threat** , ETA, EWA	EQ Parameters, **Tsunami Threat**, ETA, EWA	--	3	**Inundation Threat**	**Evacuate based on maps or criteria**	**Actions issued by National/ Local Authorities for Public Response**
							2	**Coastal Marine Threat**	**Out of water/off boats**	
	EQ Parameters, **Undecided Tsunami Threat** (due to travel time greater than 2/3 hours)	EQ Parameters, **Undecided Tsunami Threat**, Threat Level as reported by NTWC, Tsunami Observations		EQ Parameters, **Undecided Tsunami Threat** ETA, EWA	EQ Parameters, **Undecided Tsunami Threat** ETA, EWA, Tsunami Observations		1	**Potential Land/Marine Threat (2/3 hours away)**	**On alert/Wait for more information**	
	EQ Parameters, **Slight Fluctuations (or) No Potential for Destructive Tsunami**	--		**EQ parameters No Threat**	**--**		0	**No Threat**	**No Action**	
			Threat Passed			**Threat Passed**	0	**Threat Cancellation**	**All Clear**	
Dissemination Modes	**RTSPs -> Public**: GTS, Email, Fax, Web Site, SMS **RTSPs -> NTWCs**: Private distribution by Password Protected Sites						**NTWC -> RTSPs**: Email, Telephone, Fax, Web **NTWC -> Public**: Email, SMS, Web sites, TV/Radio, Loudspeakers, sirens, traditional methods			

Note:

- **Earthquake parameters** to be included in the Public & Exchange bulletins include: Latitude, longitude, magnitude, depth, time of occurrence.
- **Tsunami Parameters** to be included in the Exchange Bulletins include: Threat Status for different Coastal Forecast Zones/Points, Expected Time of Arrival (ETA), Expected Wave Amplitude (EWA), Tsunami Observations from Tide Gauges and Tsunameters as and when available.
- The criteria for determination of Threat Status to be used by the RTSPs in the Tsunami Exchange bulletins and the coastal zones/points to be used for issue of bulletins will be decided by each ICG in consultation with its Member States.
- The criteria for determination of Threat Level at the National level and any action to be taken in response will be decided by the NTWCs of the respective Member States in consultation with their National/Local authorities.

3.5 COMMON SPATIAL DATASET AS A TOOL FOR INTER-OPERABILITY BETWEEN RTSPS

The level of risk posed by tsunami is well determined by understanding of complex spatial and temporal dependence among multiple datasets. It is unreasonable to expect individuals involved in disaster response management to analyze these complex interactions under emergency conditions without errors. When multiple centres are involved for the analysis, the possibility of misinterpretation increases due to multiple ways of data handling. To ensure interoperability between the multiple centres it is important to use a common spatial data for delivery of tsunami advisories.

RTSPs can use this common spatial dataset for generation of public bulletins as well as detailed exchange bulletins. The NTWCs can use the information provided for each of its coastal regions to formulate its own national bulletins during an event. Use of common spatial data will not only facilitate inter-RTSP performance comparisons but also enable NTWCs to realistically compare RTSP products. Each element in the common spatial dataset represents a specific point/region along the coast that is well known to emergency managers and the populace. Each element is provided with model-derived information such as expected tsunami amplitude, expected time of arrival, threat level, etc. which enables the NTWCs to make a decision during the event. This common spatial dataset is to be finalized in consultation with the NTWCs.

3.6 DISSEMINATION METHODS

NTWCs and RTSPs should use all possible means of communication available to them to reach the target groups. The most widely used means for dissemination of tsunami advisories/alerts in different ICGs are GTS, AFTN, FAX, email, Web, SMS, RSS, CAPS, AWIPS, NWW, NAWAS, HAWAS, IDN, CISN, etc. These dissemination methods are detailed in Annex III. In addition to the above, the following methods may be most suitable for dissemination of public and exchange bulletins to specific target groups:

- RTSPs to Public: Tsunami Public bulletins could be disseminated by GTS, Email, FAX, SMS, Websites;
- RTSPs to NTWCs: Detailed Tsunami Exchange bulletins could be privately disseminated by password protected websites. A brief notification alerting the NTWCs to the issue of a detailed bulletin could be sent by GTS, Email, FAX, SMS, etc.;
- NTWCs to RTSPs: SITREPS or Warning Status reports from NTWCs to RTSPs could be sent by email, telephone, fax, websites, etc.;
- NTWCs to Public: Public alerting could be done through email, SMS, websites, TV/Radio, loudspeakers, sirens and other traditional methods.

3.7 GUIDELINES FOR THE REVIEW OF OPERATIONS

3.7.1 Capability Requirements

In order to provide required service and undertake agreed SOPs, Regional TWS should come up with a set of capability requirements that each of the RTSPs will need to demonstrate. A few important ones are listed below:

- Access to real time data sources and capability to produce standardized seismic and sea-level parameters;
- Appropriate historical database of earthquakes and tsunamis;
- Maintain or have access to benchmark, pre-calculated numerical model scenarios;
- Revise advisories in light of additional seismic and sea level data;
- Provide timely and effective Tsunami advisory to respective NTWCs;
- Provide products in globally standard formats;
- Exchange warnings freely and timely on the GTS and Internet and all other possible means of communication;
- Adequate trained and experienced staff, utilities, and resources to operate functionally 24 hours per day, seven days per week (24/7);
- Adequate infrastructure and back-up facilities to continue operating during power cuts and national emergencies such as all critical equipment on 30-min UPS, generator or alternative power backup (with 1 day of back-up capability), all critical equipment operating in duplicate and all critical communications circuits with backup;
- Staff should be able to communicate in English and at least one more of the local languages.

3.7.2 Performance Indicators

The following performance indicators are proposed to measure performance of the RTSPs. The target values mentioned against each of the parameter are only indicative and detailed investigation in both scientific and sociological means should be further conducted to arrive at the exact values. These parameters could vary between different ICGs, based on the local seismotectonic settings, available warning times, etc. It should be noted that there are no absolute measures for criteria such as earthquake magnitude, and that accuracy can only be best gauged in some cases by comparing analyzed values amongst agencies (i.e. absolute accuracy may not be known).

Elapsed time from earthquake to earthquake information issuance (local)	10 min
Elapsed time from earthquake to earthquake information issuance (distant)	15 min
Elapsed time from any product issuance to potential receipt by NTWC/TWFPs	5 min
Percent of countries issued a timely product as defined above	100%
Probability of Detection of earthquakes with Mw>=6.5	100%
Accuracy of earthquake hypocenter location	30km
Accuracy of earthquake hypocenter depth	25km
Accuracy of earthquake Mw magnitude	0.2
Accuracy of the tsunami forecast amplitude/height	factor of 2
Reliability of RTSP operations (power, computers, communications)	99.5%
Contact information updated and communications systems successfully tested quarterly	

3.7.3 Process for verifying the operational status of RTSP and review of tsunami watch operations

It is extremely important to have a formal process for verifying the operational status of RTSPs and review the tsunami watch operations. Each ICG pursues its mandate, through Working Groups and Task Teams addressing different aspects of Tsunami Warning & Mitigation. The capability requirements and performance indicators defined by each ICG serve as guidelines to verify the operational status of an RTSP and review its tsunami watch operations.

Once an RTSP assumes service, its performance is compared against the performance indicators set forth by the respective ICG. Discussions in some ICGs (e.g. ICG/IOTWS) concluded that a formal accreditation process would be too difficult to implement and hence acceptance should be by peer review of comparative performance, which would require complete transparency to provide confidence in the service. To make the process transparent, it was proposed that the performance indicators of each RTSP will be uploaded automatically to a website which could be used by the NTWCs to monitor the RTSP performance. This entire process is guided by the working groups and a task team within the ICG. Other ICGs are also in the process of coming up with guidelines.

While further discussions are needed to come up with concrete recommendations, the following are a couple of possible options:

- Yearly review by a Task Team within each ICG;
- Review by an external review panel with other ICGs and experts outside the ICG.

3.7.4 Mechanism to ICGs for the coordination of Tsunami Watch Operations

There currently is no mechanism, other than TOWS and this Task Team, for addressing the issue of coordination of tsunami watch operations among the four Tsunami Warning Systems (TWSs), yet the operational centres of the PTWS, IOTWS, CARIBE-EWS and NEAMTWS, face many common challenges. These include the rapid detection, monitoring and forecasting of tsunamis, the reliable and effective communication of operational tsunami products, and the management of information during crisis operations. While there are certain differences between the tsunami hazard, tsunami vulnerability, size and shape of the potentially affected bodies of water, number of countries, local culture and language, and available resources for each centre and its area of responsibility, there are also many commonalities that can best be addressed through a coordinated approach among all the systems and centres. Further, a system of systems that is globally coordinated is more likely to be effective.

A perpetual body, composed of two representatives from each ICG should be formed. Its terms of reference should include the development and maintenance of standards and guidelines for:

- Operational procedures and methodologies
- Operational products
- Coordination of product content during crisis operations
- Product dissemination
- Product terminology

- Documentation
- Coordination of products among the TWS's.

The TOR should also include the development of centre performance standards, and procedures for monitoring and reporting on centre performance. The body should specifically work towards globally harmonizing the above to the extent possible.

Within the four systems and their ICGs there are mechanisms for addressing some of these issues, but these are often overlapping and redundant efforts with inconsistent results. None address global harmonization and coordination.

3.8 DOCUMENTATION REQUIREMENTS

To be effective, an NTWC or RTSP requires documentation that clearly states the centre's mandate, authority, and relationship to other government agencies. Equally important are references that document the centre's concept of operations, standard operating procedures, and agreements with partners and customers. In June 2007, the UNESCO/IOC Tsunami Coordination Unit recommended that NTWCs and RTSPs include, at a minimum, the following documentation:

NTWC/RTSP Concept of Operations (CONOPS): This is a document that is global, basin-wide, or countrywide in scope, depending upon the AOR of the centre. It should be a high-level document for decision-makers and describe the system and how it functions in general terms. It should identify who is involved and clearly define their roles and responsibilities.

Operations Manual: This document details how a particular NTWC or a Disaster Management Office's Emergency Operations Centre (EOC) works to carry out its roles and responsibilities. The manual should be designed to be used by the duty people at that centre. It should include information on emergency management plans and standard operating procedures (SOP), such as criteria for action, data streams, communications links, analysis software, messaging software, notification and dissemination methods, and general troubleshooting.

Operations Troubleshooting Manual: This document should provide details on what actions to take when a system has failed. This can be computer hardware failure, communications link failure, a software problem, etc. It should be maintained by the NTWC or RTWP as appropriate.

Tsunami Warning System Users Guide: This guide should contain general information for customers on tsunamis and the tsunami threat, tsunami warning centre procedures, and the criteria for action, along with sample messages. It should include a general description of that centre's system: seismic data, sea-level data, warning centre message dissemination, public safety actions, and public responses, including evacuation. It should also include guidance on what the user or customer can expect from the tsunami warning centre, including how to interpret messages for action, definitions of terms, and what to do when warnings are issued. For RTSPs the document may be maintained by the IOC. For a national system, it should be maintained jointly by the NTWC and partners.

NTWC/RTSP Stakeholder Contacts: This document generally comprises contacts responsible for overall tsunami mitigation, for tsunami warning operations, and for tsunami emergency response operations. For RTSPs these are Tsunami Warning

Focal Points (TWFP) or ICG Tsunami National Contacts (TNC). For NTWCs, the document should be similar but involve emergency response as well.

Tsunami Warning System Directives: This is a collection of official, authoritative documents covering national or local procedures and responsibilities. Descriptions are in more detail than CONOPS, but less detail than operations manuals. Directives describe the authority, coordination, roles, and responsibilities of services and organizations involved.

Tsunami Emergency Response Plans (TERP): NTWCs and their National Disaster Management Office (NDMO) partners must create and customize written Tsunami Emergency Response Plans (TERP) to meet their specific needs.

4. CONCLUSION

The task of harmonization of tsunami watch operations within and among regional tsunami warning systems is a complex task. The suggestions and recommendations put forth in this document are based on best-practice and intend to serve only as a broad guidance to the ICGs in planning and development of their systems. While the specific requirements of each region will continue to drive the evolution of each ICG, following a common framework, as put forth in this document, will ensure that operations within and among different regional systems become seamless and interoperable. The task of harmonization of tsunami watch operations is a continuing one and as proposed in this document, is to be driven by representatives of the major stakeholders, i.e. all the ICGs.

ANNEX I

AGENDA

1. OPENING AND SESSION ORGANIZATION
2. PRESENTATION ON THE PROGRESS OF TT3
3. BRIEF PRESENTATIONS FROM THE ICG REPRESENTATIVES
4. AREAS OF RESPONSIBILITIES, GEOGRAPHICAL COVERAGE, SYSTEM ARCHITECTURES AND IN EACH OF THE ICGS
5. PROCEDURES, TERMINOLOGIES, PRODUCTS AND DISSEMINATION MECHANISMS USED FOR TSUNAMI WATCH OPERATIONS – CURRENT & FUTURE
6. PROCESS FOR VERIFYING THE STATUS OF TSUNAMI WATCH OPERATORS AND GUIDELINES FOR THE REVIEW OF TSUNAMI WATCH OPERATIONS
7. DISCUSSION ON ACTION ITEMS FOR TT 3 PRIOR NEXT TOWS MEETING 2011
8. DISCUSSION OF CROSS-CUTTING ISSUES RELATED TO OTHER TASK TEAM OF TOWS
9. JOINT MEETING WITH THE TT1 AND TT2

ANNEX II

CURRENT TERMINOLOGIES FOLLOWED FOR TSUNAMI WATCH OPERATIONS

ALL CLEAR	An “All Clear”, or its equivalent, is usually issued by local authorities following any type of near or actual disaster to inform the public that it is safe to re-enter evacuated areas and resume normal activities.
Amplitude	For the PTWC and WC/ATWC tsunami amplitude is measured relative to normal sea level. On the other hand, the NWPTAC reports amplitude in 0.1 meter unit by measuring half of trough to crest height. (PTWS/CARIBE-EWS/IOTWS)
Coastal Forecast Points	Off shore points selected at a certain sea depth till where estimated tsunami amplitude is calculated by the equation of hydrodynamics. Usually, tsunami wave height at coast is calculated by Green's law using the values on these points.
Coastal Forecast Zones	To ensure interoperability between the RTWPs and NTWCs, it was decided that all the Indian Ocean RTWPs will use a common spatial data set of specific “coastal forecast zones” for providing tsunami advisories. Every coastal forecast zone in the spatial data shall be provided with attributes such as max_beach, max_deep, depth, threat category, travel times (T1, T2, T3, T4). (IOTWS)
Depth	Focal depth of the earthquake. Seismogically, earthquakes occurring at a depth of 100 km or more considered not to generate tsunami regardless of its magnitude. (PTWS/ CARIBE-EWS/IOTWS)
Double Amplitude	Wave amplitude from a trough to crest or a crest to trough. (PTWS/WCATWC)
Earthquake magnitude	The magnitude used is the moment magnitude, Mw. It is more accurate for large earthquakes than the more common Richter magnitude. The moment magnitude determined by PTWC for initial products is Mwp, based on the first arriving seismic P waves. Subsequent estimates of Mw may be made by methods based on later arriving seismic waves. (PTWS/CARIBE-EWS/IOTWS)
Estimated Amplitude of Tsunami:	The highest estimated crest relative to normal sea level. (NWPTAC)

Final Bulletin	RTSP services shall conclude for a specific event when the expected time for the last IO country Threat Threshold to be no longer exceeded has passed + 2 hrs. This bulletin shall be called a FINAL BULLETIN for the event. (IOTWS)
Initial Estimated Arrival Times	Computed from the epicentre of the earthquake to each forecast point using the physics principle that a wave will travel from point A to point B over whatever path in the ocean gets it there the fastest. (PTWC/NWPTAC/WCATWC/CARIBE-EWS/IOTWS)
Interim Tsunami Advisory Service	The Tsunami Advisory Service being provided by PTWC & JMA to the Indian Ocean region, until regional capacity is developed. While PTWC and JMA have no authority or responsibility to issue tsunami warnings outside their regions of responsibility, they have provided tsunami-relevant information to Indian Ocean nations since April 2005 on an interim basis. At national level, each Member State is responsible for issuing warnings to its own citizens through their NTWC.
Location	Latitude and longitude of the earthquake. Tsunami is not generated by earthquakes occurring in inland areas. However, possibilities are not excluded if its epicentre is located very close to the sea. (PTWS/CARIBE-EWS/IOTWS)
Max_deep	Maximum positive wave amplitude in deep water in each coastal zone (IOTWS).
Max_beach	Maximum positive wave amplitude at the shore-line (IOTWS).
NTWC	National Tsunami Warning Centre is the agency/organization established for acting on few procedures/protocols in a way to save lives and reduce property damage in case of tsunami. NTWCs, through bilateral arrangements, will be able to choose the RTWPs from which they wish to access tsunami watch information from (IOTWS).
Period	Period of time in minutes from one crest to the next. (PTWS/IOTWS)
Service Levels	Three Service Levels are proposed in association with the phased implementation and maturity of the RTSP “system-of-systems” of IOTWS. • **Service Level 1**: Interim Service provided currently by JMA and PTWC for ICG/IOTWS which contain Earthquake source information to determine potential tsunami threat and travel times. (IOTWS)

- **Service Level 2**: RTSPs issue more specific tsunami watch information for NTWCs. The information contains the results of forecast model which provides Estimated Wave Amplitude (EWA), Estimate Time of Arrival (ETA), Threat levels based on model simulations. (IOTWS)
- **Service Level 3**: RTSPs will develop and implement enhanced tsunami warning information using Inundation mapping and Risk and Hazard assessments for NTWCs in association with RTWPs. (IOTWS)

T1	Time of arrival of the minimum detectable positive amplitude wave (IOTWS).
T2	First exceedance of the threat threshold (IOTWS).
T3	Time of arrival of max_beach (IOTWS).
T4	Time when the last exceedance of the Threat Threshold is forecast (IOTWS).
Threat Passed	120 minutes after the last exceedance of 0.5 M threat threshold at last Member State of that ocean basin (IOTWS).
THREAT/NO THREAT	A country is considered under THREAT when a predicted positive wave amplitude ≥ 0.5 metre at the coast at any location in that country. Otherwise, the country is under NO THREAT. (IOTWS)
Time of the Measurement	Time when the centre measured tsunami amplitude showed in its bulletin. (PTWC/NWPTAC/WCATWC)
Tsunami Advisory	The third highest level of tsunami alert. Advisories are issued to coastal populations within areas not currently in either warning or watch status when a tsunami warning has been issued for another region of the same ocean. An Advisory indicates that an area is either outside the current warning and watch regions or that the tsunami poses no danger to that area. PTWC will continue to monitor the event, issuing updates at least hourly. As conditions warrant, the Advisory will either be continued, upgraded to a watch or warning, or ended. (PTWS) Issued due to the threat of a potential tsunami which may produce strong currents or waves dangerous to those in or near the water. Coastal regions historically prone to damage due to strong currents induced by tsunamis are at the greatest risk. The threat may continue for several hours after

	the arrival of the initial wave, but significant widespread inundation is not expected for areas under an advisory. Appropriate actions to be taken by local officials may include closing beaches, evacuating harbours and marinas, and the repositioning of ships to deep waters when there is time to safely do so. Advisories are normally updated to continue the advisory, expand/contract affected areas, upgrade to a warning, or cancel the advisory. (CARIBE EWS when CTWC is established) Tsunami wave height less than 0.5 m and/or tsunami run-up less than 1 m; currents, Bore, recession, damage in harbours, small inundation on beaches expected. (NEAMTWS) The status of all bulletins issued by NWPTAC is Tsunami Advisory. Interim Service provided by PTWS outside their AOR is also known Tsunami Advisory Service.
Tsunami Arrival Time	Time when the tsunami appears on the record. (PTWC/NWPTAC/WCATWC)
Tsunami current velocity	The velocity of sea-water current caused by tsunami wave, usually referred to those in a bay or harbour. Tsunami with negative amplitude below normal sea level may also cause damage to facilities like rafts for oyster farming, etc. because of its high current velocity.
Tsunami Information	A message issued to advise the NEAM recipients of the occurrence of a major earthquake in the area but with an evaluation that there is no tsunami threat. (NEAMTWS)
Tsunami Information Statement/Bulletin	A message issued to advise IOTWS participants of the occurrence of a major earthquake with an evaluation that there is either: (a) no widespread tsunami threat but the small possibility of a local tsunami, or (b) there is no tsunami threat at all because the earthquake is located inland or deep inside the earth. A supplement or higher level of alert will be issued if tsunami waves are observed on nearby sea level gauges. (PTWS/CARIBE-EWS/IOTWS)
Tsunami National Contact (TNC)	The person designated by a Member State to an Intergovernmental Coordination Group (ICG) to represent his/her country in the coordination of international tsunami warning and mitigation activities. The person is part of the main stakeholders of the national tsunami warning and mitigation system. The person may be the Tsunami Warning Focal Point, from the national disaster management organization, from a technical or scientific institution, or from another agency with tsunami warning and mitigation responsibilities. (PTWS/NWPTAC/WCATWC/NEAMTWS)

Tsunami Potential	Tsunamigenic potential of an earthquake is evaluated according to the magnitude of an earthquake (PTWS/CARIBE-EWS/IOTWS)
Tsunami Warning	The highest level of tsunami alert. (1) Imminent threat (usually within the next three hours) of a tsunami from a large undersea or near shore earthquake; or (2) following confirmation that a potentially destructive tsunami is crossing the Pacific that may destructively impact coasts along part or all of the named areas. They may initially be based only on seismic information as a means of providing the earliest possible alert. Warnings advise that appropriate actions be taken in response to the tsunami threat. Warnings are updated at least hourly or as conditions warrant to continue, expand, restrict, or end the warning. (PTWS/CARIBE-EWS when CTWC is established)
Tsunami Warning Focal Point (TWFP)	The 7x24 contact person, or other official point of contact or address, is available at the national level for rapidly receiving and issuing tsunami event information (such as warnings). The Tsunami Warning Focal Point either is the emergency authority (civil defence or other designated agency responsible for public safety), or has the responsibility of notifying the emergency authority of the event characteristics (earthquake and/or tsunami), in accordance with national standard operating procedures. The Tsunami Warning Focal Point receives international tsunami warnings from the PTWC, WC/ATWC, the JMA NWPTAC, or other regional warning centres. (PTWS/NWPTAC/WCATWC/CARIBE EWS /IOTWS/NEAMTWS)
Tsunami Watch	The second highest level of tsunami alert. Watches are issued by the TWCs based on seismic information without confirmation that a destructive tsunami is underway. It is issued as a means of providing an advance alert to areas that could be impacted by destructive tsunami waves. Watches are updated at least hourly to continue them, expand their coverage, upgrade them to a Warning, or end the alert. A Watch for a particular area may be included in the text of the message that disseminates a Warning for another area. (PTWS). Tsunami watch is issued to alert emergency management officials and the public of an event which may later impact the watch area. The watch area may be upgraded to a warning or advisory – or cancelled – based on updated information and analysis. Therefore, emergency management officials and the public should prepare to take action. Watches are normally issued based on seismic information without confirmation that a destructive tsunami is underway (CARIBE EWS when CTWC is established).

Tsunami wave height greater than 0.5 m and/or tsunami run-up greater than 1 m; coastal inundation expected. (NEAMTWS).

Local Tsunami Watch – A message issued to advice participants of the potential or confirmed destructive tsunami threat to coasts within about 100 km of the earthquake epicentre (Interim Service provided by PTWS outside their AOR).

Regional Tsunami Watch – A message issued to advice participants of the Potential or confirmed destructive tsunami threat to coasts within about 1000 km of the earthquake epicentre. (Interim Service provided by PTWS outside their AOR).

Ocean/Sea-Wide Tsunami Watch – A message issued to advice participants of the Potential or confirmed destructive tsunami threat to all coasts bordering the Ocean/Sea basin. (Interim Service provided by PTWS outside their AOR).

Warning Cancellation

A cancellation indicates the end of the damaging tsunami threat. A cancellation is usually issued after an evaluation of sea-level data confirms that a destructive tsunami will not impact the warned area. A cancellation will also be issued following a destructive tsunami when sea-level readings indicate that the tsunami is below destructive levels and subsiding in most locations that can be monitored by PTWC (PTWS), CARIBE EWS.

ANNEX III

DESCRIPTION OF DISSEMINATION METHODS

Aeronautical Fixed Telecommunications Network (AFTN): AFTN is a dedicated circuit that goes to airfield facilities around the world. Its primary use is for communication of information related to airfield operations. However, this circuit is often also connected to NMHCs because they provide airfields with weather information. Through the AFTN, tsunami products are received by either a 24x7 airfield facility or the NMHC to trigger tsunami protection actions when necessary. AFTN is currently used only in the PTWS and CARIBE EWS.

AWIPS: The advanced Weather Information Processing System (AWIPS) is operated by the U.S. National Weather Service (NWS) to exchange weather information and products between its offices throughout the country. PTWCs products are entered into AWIPS though U.S. National Weather Service Telecommunications Gateway (NWSTG) in Silver Spring Maryland. NWS Weather Forecast Offices that play an important role in the timely dissemination of tsunami products to the local communities receive U.S TWC products via AWIPS.

CAPS: Common Alerting Protocol (CAP) is an XML-based data format for exchanging public warnings and emergencies between alerting technologies. CAP allows a warning message to be consistently disseminated simultaneously over many warning systems to many applications. CAP increases warning effectiveness and simplifies the task of activating a warning for responsible officials.

CISN: Web-based tool for first responders, emergency managers, and critical lifeline organizations to provide reliable access to earthquake information from the CISN and other networks.

Email: Most of the NTFPs have designated one or more email addresses for receiving products from the operational centres. Limitations are that email servers are sometimes down and that email needs a way to be quickly recognized when it comes in. However, email can support both text and graphical products.

Fax: Most of the NTFPs have designated one or more fax numbers for receiving products from the operational centres. Limitations are that fax machines may be busy or turned off or out of order when faxes are disseminated. Faxes also need a way to be quickly recognized when they come in. Also, faxes are best for text messages or simple black and white graphics.

Global Telecommunications System (GTS): The GTS is operated by the World Meteorological Organization (WMO). This is a dedicated circuit connected to the National Meteorological and Hydrological Centres (NMHCs) of most countries around the globe. Since the national tsunami warning responsibility of many countries resides with their national meteorological agency and since their NMHCs typically have 24x7 operations, this is an effective means for alerting for a tsunami threat with a text message. Shortcomings of the GTS are that it does not reach some of the more remote countries like certain Pacific island states or countries where the tsunami warning responsibility resides with another agency such as the Navy. Also, the GTS does not widely support the higher bandwidth required for disseminating graphical products such as tsunami travel time maps or tsunami forecast energy distribution plots.

HAWAS: The Hawaii Warning system is a state-wide dedicated voice telephone system connecting selected State Civil Defence, National Guard, Law Enforcement and NWS offices.

IDN: Hawaii State Civil Defence maintains the Interisland Data Network, an email service utilizing a private TCP/IP circuit that connects PTWC with all Hawaii State and County Civil Defence offices.

NAWAS: The National Warning System is a nationwide dedicated vice telephone system connecting selected national defence, emergency management and coast guard agencies. PTWC uses NAWAS only when it is action as a backup for WC/ATWC.

NWW: The NOAA Weather Wire is a satellite broadcast service maintained by the NWS to disseminate weather products domestically in the U.S. PTWC has both uplink and downlink capabilities on the NWW system.

RSS: Really Simple Syndication (RSS) includes full or summarized text, plus metadata. RSS feeds benefit publishers by letting them syndicate content automatically. They benefit readers who want to subscribe to timely updates from favoured websites or to aggregate feeds from many sites into one place. This could be effectively used for Tsunami Bulletin dissemination.

SMS: Short text messages via Short Message Service (SMS) could be sent out to mobile phones of authorized users drawing their attention to the occurrence of an earthquake or issue of a tsunami advisory. SMS could also be broadcast warnings to public.

Web: All of the current operational centres have websites that are used for displaying their current products and for displaying additional graphical products. Websites are not practical for alerting NTFPs to an event, but are an excellent way to provide key information about an event once the event is known. Tsunami Exchange bulletins could be disseminated to designated NTWCs using password protected websites. To access the website effectively, a TWFP needs internet access with a reasonable speed. In addition, the website must be capable of handling the millions of hits that can occur during a major tsunami event.

ANNEX IV

REFERENCE DOCUMENTS

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In this Series, entitled

Reports of Meetings of Experts and Equivalent Bodies, which was initiated in 1984 and which is published in English only, unless otherwise specified, the reports of the following meetings have already been issued:

1. Third Meeting of the Central Editorial Board for the Geological/Geophysical Atlases of the Atlantic and Pacific Oceans
2. Fourth Meeting of the Central Editorial Board for the Geological/Geophysical Atlases of the Atlantic and Pacific Oceans S. Fourth Session of the Joint IOC-WMO-CPPS Working Group on the Investigations of 'El Niño' ***(Also printed in Spanish)***
4. First Session of the IOC-FAO Guiding Group of Experts on the Programme of Ocean Science in Relation to Living Resources
5. First Session of the IOC-UN(OETB) Guiding Group of Experts on the Programme of Ocean Science in Relation to Non-Living Resources
6. First Session of the Editorial Board for the International Bathymetric Chart of the Mediterranean and Overlay Sheets
7. First Session of the Joint CCOP(SOPAC)-IOC Working Group on South Pacific Tectonics and Resources
8. First Session of the IODE Group of Experts on Marine Information Management
9. Tenth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies in East Asian Tectonics and Resources
10. Sixth Session of the IOC-UNEP Group of Experts on Methods, Standards and Intercalibration
11. First Session of the IOC Consultative Group on Ocean Mapping ***(Also printed in French and Spanish)***
12. Joint 100-WMO Meeting for Implementation of IGOSS XBT Ships-of-Opportunity Programmes
13. Second Session of the Joint CCOP/SOPAC-IOC Working Group on South Pacific Tectonics and Resources
14. Third Session of the Group of Experts on Format Development
15. Eleventh Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of South-East Asian Tectonics and Resources
16. Second Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean and Overlay Sheets
17. Seventh Session of the IOC-UNEP Group of Experts on Methods, Standards and lntercalibration
18. Second Session of the IOC Group of Experts on Effects of Pollutants
19. Primera Reunión del Comité Editorial de la COI para la Carta Batimétrica lnternacional del Mar Caribe y Parte del Océano Pacífico frente a Centroamérica ***(Spanish only)***
20. Third Session of the Joint CCOP/SOPAC-IOC Working Group on South Pacific Tectonics and Resources
21. Twelfth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of South-East Asian Tectonics and Resources
22. Second Session of the IODE Group of Experts on Marine Information Management
23. First Session of the IOC Group of Experts on Marine Geology and Geophysics in the Western Pacific
24. Second Session of the IOC-UN(OETB) Guiding Group of Experts on the Programme of Ocean Science in Relation to Non-Living Resources ***(Also printed in French and Spanish)***
25. Third Session of the IOC Group of Experts on Effects of Pollutants
26. Eighth Session of the IOC-UNEP Group of Experts on Methods, Standards and lntercalibration
27. Eleventh Session of the Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans ***(Also printed in French)***
28. Second Session of the IOC-FAO Guiding Group of Experts on the Programme of Ocean Science in Relation to Living Resources
29. First Session of the IOC-IAEA-UNEP Group of Experts on Standards and Reference Materials
30. First Session of the IOCARIBE Group of Experts on Recruitment in Tropical Coastal Demersal Communities ***(Also printed in Spanish)***
31. Second IOC-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes
32. Thirteenth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of East Asia Tectonics and Resources
33. Second Session of the IOC Task Team on the Global Sea-Level Observing System
34. Third Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean and Overlay Sheets
35. Fourth Session of the IOC-UNEP-IMO Group of Experts on Effects of Pollutants
36. First Consultative Meeting on RNODCs and Climate Data Services
37. Second Joint IOC-WMO Meeting of Experts on IGOSS-IODE Data Flow
38. Fourth Session of the Joint CCOP/SOPAC-IOC Working Group on South Pacific Tectonics and Resources
39. Fourth Session of the IODE Group of Experts on Technical Aspects of Data Exchange
40. Fourteenth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of East Asian Tectonics and Resources
41. Third Session of the IOC Consultative Group on Ocean Mapping
42. Sixth Session of the Joint IOC-WMO-CCPS Working Group on the Investigations of 'El Niño' (***Also printed in Spanish)***
43. First Session of the IOC Editorial Board for the International Bathymetric Chart of the Western Indian Ocean
44. Third Session of the IOC-UN(OALOS) Guiding Group of Experts on the Programme of Ocean Science in Relation to Non-Living Resources
45. Ninth Session of the IOC-UNEP Group of Experts on Methods, Standards and lntercalibration
46. Second Session of the IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico
47. Cancelled
48. Twelfth Session of the Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans
49. Fifteenth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of East Asian Tectonics and Resources
50. Third Joint IOC-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes
51. First Session of the IOC Group of Experts on the Global Sea-Level Observing System
52. Fourth Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean
53. First Session of the IOC Editorial Board for the International Chart of the Central Eastern Atlantic ***(Also printed in French)***
54. Third Session of the IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico ***(Also printed in Spanish)***
55. Fifth Session of the IOC-UNEP-IMO Group of Experts on Effects of Pollutants
56. Second Session of the IOC Editorial Board for the International Bathymetric Chart of the Western Indian Ocean
57. First Meeting of the IOC *ad hoc* Group of Experts on Ocean Mapping in the WESTPAC Area
58. Fourth Session of the IOC Consultative Group on Ocean Mapping
59. Second Session of the IOC-WMO/IGOSS Group of Experts on Operations and Technical Applications

60. Second Session of the IOC Group of Experts on the Global Sea-Level Observing System
61. UNEP-IOC-WMO Meeting of Experts on Long-Term Global Monitoring System of Coastal and Near-Shore Phenomena Related to Climate Change
62. Third Session of the IOC-FAO Group of Experts on the Programme of Ocean Science in Relation to Living Resources
63. Second Session of the IOC-IAEA-UNEP Group of Experts on Standards and Reference Materials
64. Joint Meeting of the Group of Experts on Pollutants and the Group of Experts on Methods, Standards and Intercalibration
65. First Meeting of the Working Group on Oceanographic Co-operation in the ROPME Sea Area
66. Fifth Session of the Editorial Board for the International Bathymetric and its Geological/Geophysical Series
67. Thirteenth Session of the IOC-IHO Joint Guiding Committee for the General Bathymetric Chart of the Oceans ***(Also printed in French)***
68. International Meeting of Scientific and Technical Experts on Climate Change and Oceans
69. UNEP-IOC-WMO-IUCN Meeting of Experts on a Long-Term Global Monitoring System
70. Fourth Joint IOC-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes
71. ROPME-IOC Meeting of the Steering Committee on Oceanographic Co-operation in the ROPME Sea Area
72. Seventh Session of the Joint IOC-WMO-CPPS Working Group on the Investigations of 'El Niño' ***(Spanish only)***
73. Fourth Session of the IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico ***(Also printed in Spanish)***
74. UNEP-IOC-ASPEI Global Task Team on the Implications of Climate Change on Coral Reefs
75. Third Session of the IODE Group of Experts on Marine Information Management
76. Fifth Session of the IODE Group of Experts on Technical Aspects of Data Exchange
77. ROPME-IOC Meeting of the Steering Committee for the Integrated Project Plan for the Coastal and Marine Environment of the ROPME Sea Area
78. Third Session of the IOC Group of Experts on the Global Sea-level Observing System
79. Third Session of the IOC-IAEA-UNEP Group of Experts on Standards and Reference Materials
80. Fourteenth Session of the Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans
81. Fifth Joint IOG-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes
82. Second Meeting of the UNEP-IOC-ASPEI Global Task Team on the Implications of climate Change on Coral Reefs
83. Seventh Session of the JSC Ocean Observing System Development Panel
84. Fourth Session of the IODE Group of Experts on Marine Information Management
85. Sixth Session of the IOC Editorial Board for the International Bathymetric chart of the Mediterranean and its Geological/Geophysical Series
86. Fourth Session of the Joint IOC-JGOFS Panel on Carbon Dioxide
87. First Session of the IOC Editorial Board for the International Bathymetric Chart of the Western Pacific
88. Eighth Session of the JSC Ocean Observing System Development Panel
89. Ninth Session of the JSC Ocean Observing System Development Panel
90. Sixth Session of the IODE Group of Experts on Technical Aspects of Data Exchange
91. First Session of the IOC-FAO Group of Experts on OSLR for the IOCINCWIO Region
92. Fifth Session of the Joint IOC-JGOFS CO, Advisory Panel Meeting
93. Tenth Session of the JSC Ocean Observing System Development Panel
94. First Session of the Joint CMM-IGOSS-IODE Sub-group on Ocean Satellites and Remote Sensing
95. Third Session of the IOC Editorial Board for the International Chart of the Western Indian Ocean
96. Fourth Session of the IOC Group of Experts on the Global Sea Level Observing System
97. Joint Meeting of GEMSI and GEEP Core Groups
98. First Session of the Joint Scientific and Technical Committee for Global Ocean Observing System
99. Second International Meeting of Scientific and Technical Experts on Climate Change and the Oceans
100. First Meeting of the Officers of the Editorial Board for the International Bathymetric Chart of the Western Pacific
101. Fifth Session of the IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico
102. Second Session of the Joint Scientific and Technical Committee for Global Ocean Observing System
103. Fifteenth Session of the Joint IOC-IHO Committee for the General Bathymetric Chart of the Oceans
104. Fifth Session of the IOC Consultative Group on Ocean Mapping
105. Fifth Session of the IODE Group of Experts on Marine Information Management
106. IOC-NOAA *Ad hoc* Consultation on Marine Biodiversity
107. Sixth Joint IOC-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes
108. Third Session of the Health of the Oceans (HOTO) Panel of the Joint Scientific and Technical Committee for GLOSS
109. Second Session of the Strategy Subcommittee (SSC) of the IOC-WMO-UNEP Intergovernmental Committee for the Global Ocean Observing System
110. Third Session of the Joint Scientific and Technical Committee for Global Ocean Observing System
111. First Session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate
112. Sixth Session of the Joint IOC-JGOFS C02 Advisory Panel Meeting
113. First Meeting of the IOC/WESTPAC Co-ordinating Committee for the North-East Asian Regional - Global Ocean Observing System (NEAR-GOOS)
114. Eighth Session of the Joint IOC-WMO-CPPS Working Group on the Investigations of "El Niño" ***(Spanish only)***
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125. Seventh Session of the IODE Group of Experts on Technical Aspects of Data Exchange, Ireland, 1997

126. IOC-WMO-UNEP-ICSU Coastal Panel of the Global Ocean Observing System (GOOS), First Session, France, 1997

127. Second Session of the IOC-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LME), France, 1998

128. Sixth Session of the IOC Consultative Group on Ocean Mapping (CGOM), Monaco, 1997

129. Sixth Session of the Tropical Atmosphere - Ocean Array (TAO) Implementation Panel, United Kingdom, 1997

130. First Session of the IOC-WMO-UNEP-ICSU Steering Committee of the Global Ocean Observing System (GOOS), France, 1998

131. Fourth Session of the Health of the Oceans (HOTO) Panel of the Global Ocean Observing System (GOOS), Singapore, 1997

132. Sixteenth Session of the Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans (GEBCO), United Kingdom, 1997

133. First Session of the IOC-WMO-UNEP-ICSU-FAO Living Marine Resources Panel of the Global Ocean Observing System (GOOS), France, 1998

134. Fourth Session of the IOC Editorial Board for the International Bathymetric Chart of the Western Indian Ocean (IOC/EB-IBCWIO-IW3), South Africa, 1997

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136. Seventh Session of the Joint IOC-JGOFS C02 Advisory Panel Meeting, Germany, 1997

137. Implementation of Global Ocean Observations for GOOS/GCOS, First Session, Australia, 1998

138. Implementation of Global Ocean Observations for GOOS/GCOS, Second Session, France, 1998

139. Second Session of the IOC-WMO-UNEP-ICSU Coastal Panel of the Global Ocean Observing System (GOOS), Brazil, 1998

140. Third Session of IOC/WESTPAC Co-ordinating Committee for the North-East Asian Regional - Global Ocean Observing System (NEAR-GOOS), China, 1998

141. Ninth Session of the Joint IOC-WMO-CPPS Working Group on the Investigations of 'El Niño', Ecuador, 1998 ***(Spanish only)***

142. Seventh Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean and its Geological/Geophysical Series, Croatia, 1998

143. Seventh Session of the Tropical Atmosphere-Ocean Array (TAO) Implementation Panel, Abidjan, Côte d'Ivoire, 1998

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148. Second Session of the IOC-WMO-UNEP-ICSU-FAO Living Marine Resources Panel of the Global Ocean Observing System (GOOS), France, 1999

149. Eighth Session of the Joint IOC-JGOFS CO2 Advisory Panel Meeting, Japan, 1999

150. Fourth Session of the IOC/WESTPAC Co-ordinating Committee for the North-East Asian Regional – Global Ocean Observing System (NEAR-GOOS), Japan, 1999

151. Seventh Session of the IOC Consultative Group on Ocean Mapping (CGOM), Monaco, 1999

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156. First Session of the *ad hoc* Advisory Group for IOCARIBE-GOOS, Venezuela, 1999 ***(also printed in Spanish and French)***

157. Fourth Session of the IOC-WMO-UNEP-ICSU Coastal Panel of the Global Ocean Observing System (GOOS), China, 1999

158. Eighth Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean and its Geological/Geophysical Series, Russian Federation, 1999

159. Third Session of the IOC-WMO-UNEP-ICSU-FAO Living Marine Resources Panel of the Global Ocean Observing System (GOOS), Chile, 1999

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161. Eighth Session of the IODE Group of Experts on Technical Aspects of Data Exchange, USA, 2000

162. Third Session of the IOC-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LME), France, 2000

163. Fifth Session of the IOC-WMO-UNEP-ICSU Coastal Panel of the Global Ocean Observing System (GOOS), Poland, 2000

164. Third Session of the IOC-WMO-UNEP-ICSU Steering Committee of the Global Ocean Observing System (GOOS), France, 2000

165. Second Session of the *ad hoc* Advisory Group for IOCARIBE-GOOS, Cuba, 2000 ***(also printed in Spanish and French)***

166. First Session of the Coastal Ocean Observations Panel, Costa Rica, 2000

167. First GOOS Users' Forum, 2000

168. Seventh Session of the Group of Experts on the Global Sea Level Observing System, Honolulu, 2001

169. First Session of the Advisory Body of Experts on the Law of the Sea (ABE-LOS), France, 2001 ***(also printed in French)***

170. Fourth Session of the IOC-WMO-UNEP-ICSU Steering Committee of the Global Ocean Observing System, Chile, 2001

171. First Session of the IOC-SCOR Ocean CO_2 Advisory Panel, France, 2000

172. Fifth Session of the GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC), Norway, 2000 ***(electronic copy only)***

173. Third Session of the *ad hoc* Advisory Group for IOCARIBE-GOOS, USA, 2001 ***(also printed in Spanish and French)***

174. Second Session of the Coastal Ocean Observations Panel and GOOS Users' Forum, Italy, 2001

175. Second Session of the Black Sea GOOS Workshop, Georgia, 2001

176. Fifth Session of the IOC/WESTPAC Co-ordinating Committee for the North-East Asian Regional – Global Ocean Observing System (NEAR-GOOS), Republic of Korea, 2000

177. Second Session of the Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Morocco, 2002 ***(also printed in French)***

178. Sixth Session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC), Australia, 2001 ***(electronic copy only)***

179. *Cancelled*

180. Second Session of the IOC-SCOR Ocean CO_2 Advisory Panel, Honolulu, Hawaii, U.S.A, 2002 ***(electronic copy only)***

181. IOC Workshop on the Establishment of SEAGOOS in the Wider Southeast Asian Region, Seoul, Republic of Korea, 2001 (SEAGOOS preparatory workshop) ***(electronic copy only)***

182. First Session of the IODE Steering Group for the Resource Kit, USA, 19–21 March 2001

183. Fourth Session of the IOC-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LMEs), France, 2002

184. Seventh Session of the IODE Group of Experts on Marine Information Management (GEMIM), France, 2002 ***(electronic copy only)***

185. Sixth Session of IOC/WESTPAC Coordinating Committee for the North-East Asian Regional - Global Ocean Observing System (NEAR-GOOS), Republic of Korea, 2001 ***(electronic copy only)***

186. First Session of the Global Ocean Observing System (GOOS) Capacity Building Panel, Switzerland, 2002 ***(electronic copy only)***

187. Fourth Session of the ad hoc Advisory Group for IOCARIBE-GOOS, 2002, Mexico ***(also printed in French and Spanish)***

188. Fifth Session of the IOC Editorial Board for the International Bathymetric Chart of the Western Indian Ocean (IBCWIO), Mauritius, 2000

189. Third session of the Editorial Board for the International Bathymetric Chart of the Western Pacific, Chine, 2000

190. Third Session of the Coastal Ocean Observations Panel and GOOS Users' Forum, Vietnam, 2002

191. Eighth Session of the IOC Consultative Group on Ocean Mapping, Russian Federation, 2001

192. Third Session of the Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Lisbon, 2003 ***(also printed in French)***

193. Extraordinary Session of the Joint IOC-WMO-CPPS Working Group on the Investigations of 'El Niño', Chile, 1999 ***(Spanish only; electronic copy only)***

194. Fifth Session of the IOC-WMO-UNEP-ICSU Steering Committee of the Global Ocean Observing System, France, 2002

195. Sixth Session of the IOC-WMO-UNEP-ICSU Steering Committee of the Global Ocean Observing System, South Africa, 2003

196. Fourth Session of the Coastal Ocean Observations Panel, South Africa, 2002 ***(electronic copy only)***

197. First Session of the JCOMM/IODE Expert Team On Data Management Practices, Belgium, 2003 *(also JCOMM Meeting Report No. 25)*

198. Fifth Session of the IOC-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LMEs), Paris, 2003

199. Ninth Session of the IOC Consultative Group on Ocean Mapping, Monaco, 2003 ***(Recommendations in English, French, Russian and Spanish included)***

200. Eighth Session of the IOC Group of Experts on the Global Sea level Observing System (GLOSS), France, 2003 ***(electronic copy only)***

201. Fourth Session of the Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Greece, 2004 ***(also printed in French)***

202. Sixth Session of the IOC-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LMEs), Paris, 2004 ***(electronic copy only)***

203. Fifth Session of the Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Argentina, 2005 ***(also printed in French)***

204. Ninth Session of the IOC Group of Experts on the Global Sea level Observing System (GLOSS), France, 2005 ***(electronic copy only)***

205. Eighth Session of the IOC/WESTPAC Co-ordinating Committee for the North-East Asian Regional – Global Ocean Observing System (NEAR-GOOS), China, 2003 ***(electronic copy only)***

206. Sixth Meeting of the Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Spain, 2006 ***(also printed in French)***

207. Third Session of the Regional Forum of the Global Ocean Observing System, South Africa, 2006 ***(electronic copy only)***

208. Seventh Session of the IOC-UNEP-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LMEs), Paris, 2005 ***(electronic copy only)***

209. Eighth Session of the IOC-UNEP-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LMEs), Paris, 2006 ***(electronic copy only)***

210. Seventh Meeting of the IOC Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Gabon, 2007 ***(bilingual English/French)***

211. First Meeting of the IOC Working Group on the Future of IOC, Paris, 2008 ***(Executive Summary in English, French, Russian and Spanish included)***

212. First meeting of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG), Paris, 3–4 April 2008 ***(Executive Summary in English, French, Russian and Spanish included)***

213. First Session of the Panel for Integrated Coastal Observation (PICO-I), Paris, 10–11 April 2008 ***(electronic copy only)***

214. Tenth Session of the IOC Group of Experts on the Global Sea level Observing System (GLOSS), Paris, 6–8 June 2007 ***(electronic copy only)***

215. Eighth Meeting of the IOC Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Paris, 21–25 April 2008 ***(bilingual English/French)***

216. Fourth Session of the Global Ocean Observing System (GOOS) Regional Alliances Forum (GRF), Guayaquil, Ecuador, 25–27 November 2008 ***(electronic copy only)***

217. Second Session of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG), Paris, 27 March 2009 ***(Executive Summary in English, French, Russian and Spanish included)***

218. Ninth Meeting of the IOC Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Paris, 30 March–3 April 2009 ***(bilingual English/French)***

219. First Session of the IOC-SCOR International Ocean Carbon Coordination Project (IOCCP) Scientific Steering Group (also IOCCP Reports, 3), Broomfield, Colorado, U.S.A., 1 October 2005 ***(electronic copy only)***

220. Second Session of the IOC-SCOR International Ocean Carbon Coordination Project (IOCCP) Scientific Steering Group (also IOCCP Reports, 6), Paris, France, 20 April 2007 ***(electronic copy only)***

221. Third Session of the IOC-SCOR International Ocean Carbon Coordination Project (IOCCP) Scientific Steering Group (also IOCCP Reports, 10), Villefranche-sur-mer, France, 3–4 October 2008 ***(electronic copy only)***

222. Fourth Session of the IOC-SCOR International Ocean Carbon Coordination Project (IOCCP) Scientific Steering Group (also IOCCP Reports, 15), Jena, Germany, 14 September 2009 ***(electronic copy only)***

223. First Meeting of the joint IOC-ICES Study Group on Nutrient Standards (SGONS) (also IOCCP Reports, 20), Paris, France, 23–24 March 2010 *(Executive Summary in E, F, R, S included)*

224. Third Session of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG), Lisbon, Portugal, 5–6 May 2010 ***(Executive Summary in English, French, Russian and Spanish included)***

225. Eleventh Session of the IOC Group of Experts on the Global Sea level Observing System (GLOSS), Paris, 13–15 May 2009 ***(electronic copy only)***

226. Second Session of the Panel for Integrated Coastal Observation (PICO-II), Paris, 24–26 February 2009 ***(electronic copy only)***

227. First meeting of the Task Team on Seismic Data Exchange in the South West Pacific of the ICG/PTWS Regional Working Group for the Southwest Pacific, Port Vila, Vanuatu, 19–20 October 2009 ***(electronic copy only)***

228. Fourth Session of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG), Paris, France, 20–21 March 2011 ***(Executive Summary in English, French, Russian and Spanish included)***

229. Second Session of the IODE Steering Group for Ocean Teacher (SG-OT), Miami, Florida, 11–15 April 2011

230. First Meeting of the Inter-ICG Task Team 1 on Sea Level Monitoring for Tsunami (Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG), Seattle, USA, 29 November–1 December 2010

231. First Meeting of the Inter-ICG Task Team 2 on Disaster Management and Preparedness (Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG), Seattle, USA, 29 November–1 December 2010

232. First Meeting of the Inter-ICG Task Team 3 on Tsunami Watch Operations (Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG), Seattle, USA, 29 November–1 December 2010